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SUMMER 1984 KEYNOTE ADDRESS

An Architecture History
of the
UNIX System

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(Insert after page x of Proceedings)

USENIX

Addendum to Summer 1984 USENIX Proceedings

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An Architecture History of the UNIX[†] System

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Introduction

Operating systems are a curious blend of art and technology. It might be enlightening to compare “progress” in this field of metaphorical architecture with what went on in real architecture. At least it is possible to show pictures of pretty buildings instead of the usual sequence of system names and version numbers,

The following is a biased view of part of the last thousand years of Western architecture.* In particular, there seems to be a tendency to start with a cautious design. After some experimentation, a basic design philosophy dominates, and there are buildings that make elegantly simple use of that approach to make an aesthetic statement. As designers become more comfortable with the techniques, they then make daring and ill-conceived extensions which are dominated by eccentricity and ornamentation.

We propose some plausible analogies, mostly with versions of our favorite operating system. Of course these analogies break down if examined too closely, but they may provide insight into the skein of transformations.

Before the Millennium

There were many important and impressive works of architecture before the period we are discussing. They embody the ideas of cultures with different technical abilities and social goals. An interesting example of a building that has survived a number of transformations is one of the great churches of the world, Hagia Sofia in Constantinople (now Istanbul). It was built in the sixth century, massive yet spacious. It shows much remarkable skill in construction, most especially a remarkable dome. Much of the masonry is hidden by lavish interior decoration. The church continues to stand, though it was converted to a mosque in the fifteenth century; the interior decor was completely changed, but the underlying fabric is the same. (Consider the history of IBM operating systems stretching from OS/360 through VM. They controlled machines whose speed and



Figure A: Hagia Sofia, Istanbul

[†] UNIX is a Trademark of AT&T Bell Laboratories.

* With sincere apologies to art historians.

memory size range over two orders of magnitude. They handled one or two batch users, then many batch users, then huge numbers of interactive users. Yet all ran on machines with the same operation codes, ill-suited though they may have been to the applications.)

The Romanesque Period

The great churches of the Romanesque style were admirable structures. They were based on the round (Roman) arch. To build a tall structure using these arches, very thick columns and walls were needed to counteract the forces. The buildings employ great masses of stone to enclose impressive volumes. The interiors are often dark because the builders dared leave only small breaks in the walls for windows. The interiors were often highly decorated, in part to make up for these restrictions. (The early Multics project had grand goals and was a true break with the past in many ways. Unfortunately, components of the system used much of the available space and cycles). The Romanesque style dominated for many years, and designers discovered ways to ameliorate the defects.

The Gothic Period

The Abbey of St. Denis was built in the year 1146. (It has since been destroyed). This single building is usually said to have inaugurated the Gothic style, a revolution in architecture. It made use of some innovations that had been tried in late Romanesque buildings, but the daring use of these elements constituted a breakthrough rather than an incremental improvement. The great step is usually attributed to the efforts of the Abbé Suger, though others must have contributed to its success. (The first edition of the UNIX System, due mostly to Ken Thompson, contained the seeds of all later versions.)

In quick succession (a major cathedral started each decade), other Gothic churches were built in the Ile de France. They represented a rapid evolution and codification of the concepts implicit in the model. The inventions utilized in Gothic structure made it possible to build taller buildings with thinner walls,



Figure B: Abbaye aux Dames, Caen

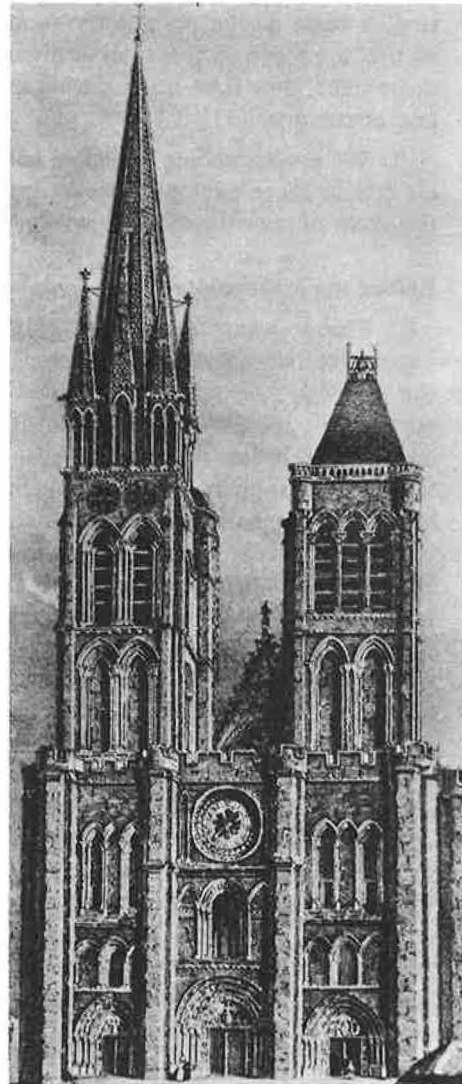


Figure C: Abbaye St. Denis

large windows filled with glorious stained glass, and more open inner space. These buildings were more graceful and simple, and were filled with brilliant light. The success is not due to the individual elements, important though they were, but to the potential they provided for a new feeling. "The decisive feature of the new style is not the cross-ribbed vault, the pointed arch, or the flying buttress... Two aspects of Gothic architecture, however, are without precedent and parallel: the use of light and the unique relationships between structure and appearance." [1] (The other early editions of UNIX contained many important modifications: system calls changed, the implementation was recoded in assembly language, then in B, then in C. Many Bell Labs people joined in the work, and then people from outside the company).

The later part of this period is usually called the *High Gothic Period*. By that time the fundamental techniques were understood and some better building materials (like higher quality stone with known limits) were found. The cathedrals of this period reflected a perfect balance between technique and beauty; simplicity and strength without gratuitous ornament. Henry Adams described the southern steeple of Chartres as "the one which they [tourists] are expected to recognize as the most perfect piece of architecture in the world." [2] The more ornate northern steeple does not match the southern steeple; it was designed after the rest of the church was done. (Some critics consider the Sixth Edition to be the finest balance of cleanliness and power; it was especially suited to small configurations.)

The High Gothic was followed by the so-called *Rayonnant* and *Flamboyant* styles in France. The basic design was the same, with continued use of flying buttresses and pointed arches, but these churches have fancy external stonework, decorated steeples, and highly decorated interiors; some of these churches contain astonishing astrological clocks. "Some critics consider these monuments as the ultimate culmination of High Gothic, while others regard their overrefinement as a sign of decadence or decline. ... The

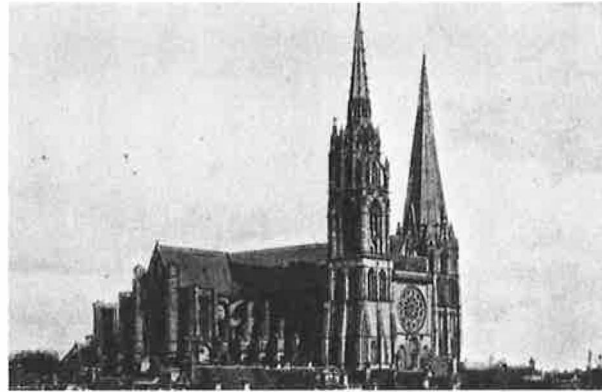


Figure D: Cathedral, Chartres

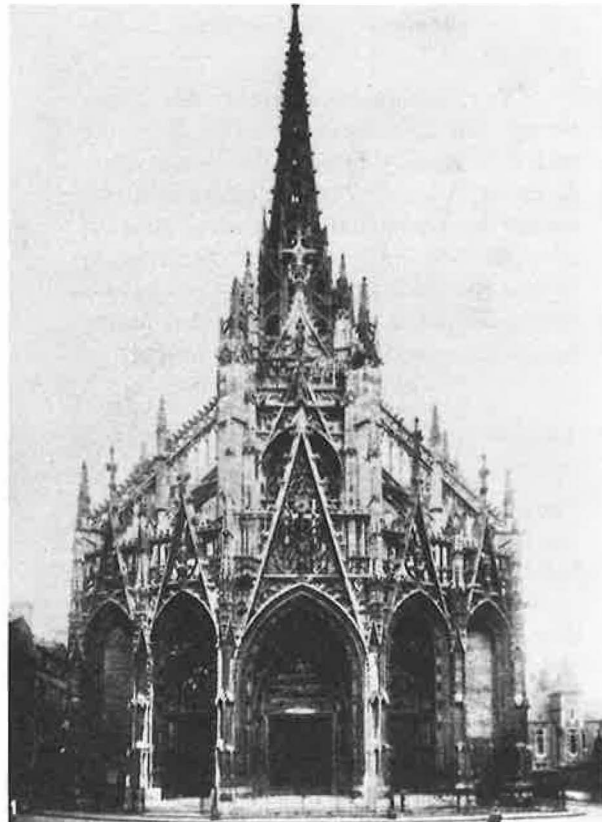


Figure E: Abbaye St. Maclou, Rouen

impact of High Gothic on structures in western Europe was soon replaced by that of the Parisian Rayonnant Gothic, the exportable Gothic". [3] (The Seventh Edition UNIX System contained many generalizations and extensions, including a file system that could manipulate much larger files. The system was the base for the VAX versions.)

The Renaissance

The Gothic period began at the end of the Middle Ages. The Renaissance followed with a different approach to, among other things, architecture. Classic models were re-examined, technologies were revived, and the early buildings were often pure and restrained. "The Renaissance building exists to be admired in its isolated perfection." [4]

However, buildings were soon built that combined grandeur and grandiosity. As a colorful example, the early chateaux constructed on the Loire echo earlier styles, but some are large and highly ornamented. (DMERT combined the different worlds of the UNIX time-sharing system and the demands of real-time performance).

The inevitable occurred, and complexity led to obsession. The following period is usually referred to as the *Mannerist*, with a style "characterized in architecture by unconventional use of classical elements." [5] Each work concentrated on certain limited aspects, treating others in a cursory manner. (System V has many interprocess mechanisms but no paging).

The Baroque and the Rococo

The trend continued, leading into the *Baroque* period, which "appeared to revel in odd, extravagant shapes" [6]. The buildings are striking and contain many startling oval patterns and eye-catching designs, but often make inefficient use of space and effort. "The Baroque building can only be grasped through one's experiencing it in its variety of effects" [4]. (Consider the 4BSD system, with its plethora of complex user commands).

The final flowering of the Baroque is usually called *Rococo*, where the

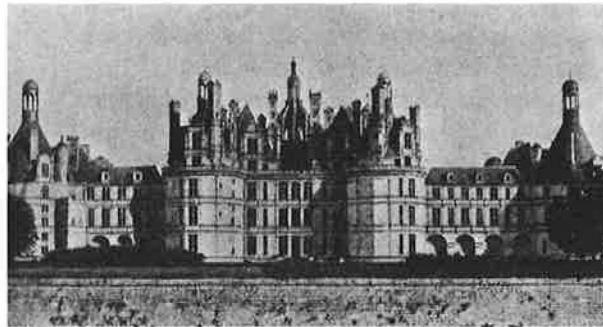


Figure F: Chambord Chateau



Figure G: Vendramini Palace, Venice

complication and ostentation was carried even further. Complex curves replace straight lines; decorations appear atop decorations. "A debased style at the best, essentially fantastic and bizarre, it ended in extravagance and decadence. .. The very exuberance of the rococo forms is, indeed, the negation of art, which is based upon restraint". [7] (The 4.2BSD system adds more features to the kernel but does not discard older, overlapping facilities, and is not yet noted for efficient use of resources).

"Rococo was the last style of Western architecture to have wide acceptance, and the aristocrats were the last international group of patrons. When it came to be identified in the minds of the people as the style of the decadent upper class, the Rococo abruptly went out of favor".[8]

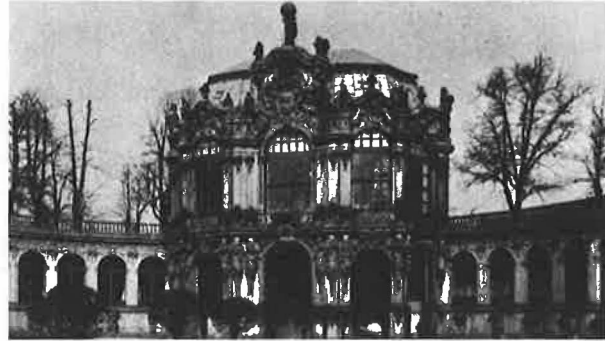


Figure H: Zwinger Palace, Dresden

Models for the Future?

The world of UNIX-related systems has proliferated (some might say metastasized). Complicated systems originally designed for many-person use on large minicomputers are being fitted to single-user workstations. Other installations run UNIX, the little system that could, on the mightiest mainframes with vast user populations. Many systems run UNIX utilities or a simulated kernel atop an entirely different, and antithetical, operating system. And some UNIX-like systems seem only the palest shadow of the original: they copy many of the system calls and standard commands in slightly botched forms.

Consider some forms of architecture which appeared after the periods mentioned above:

The *Neo-Classic* styles, which pay particular attention to form; the results are functional but sterile.

The *Romanesque Revival* or *Gothic Revival* forms attempt to create works in the basic styles of the original periods but with newer materials, producing buildings that are intentionally archaic but with fundamental strengths of character; they are often soulless reflections of the received traditions.

The *Beaux Arts* school paid great attention to detail, but sometimes produced attractive and usable designs.

A genre that might be styled *Telco Gothic* sprang up earlier this century: heavy-footed turreted buildings with complex ornaments and sprouting antennas.

The so-called *Fascist Brutalism* style is typical of totalitarian states of the mid-twentieth century, with planned communities and faceless streets of oversized ugly buildings that leak.

The *Radiant City* proposal for a modern city, in which empty parkland surrounds an enormous skyscraper.

The *International Style* manifests itself most graphically as rows of glass office buildings, airy but tedious. There are works of great artfulness, functional but beautiful; but most suffer from gimmick design and worse construction.

There are whole cities rendered as over-lit theaters, as in Disneyland or Las Vegas.

And there are burnt-out slums.

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